APPENDIX X

METHODOLOGY USED TO DEVELOP TIER 2 SCREENING TABLES FOR GASOLINE TRANSFER AND DISPENSING FACILITIES

Introduction

The purpose of this appendix is to document the methods used by SCAQMD staff to estimate cancer risks from retail gasoline dispensing facilities. The methods are consistent with SCAQMD's Risk Assessment Procedures (Version 8.1), which incorporates the 2015 OEHHA Guidelines. The methods used to estimate emissions, pollutant concentrations, and cancer risks are discussed here. Screening tables of maximum cancer risks at various locations in the South Coast Air Basin and at various residential and occupational distances are provided in Attachment N. This appendix concludes with an example calculation using the cancer risk tables.

Emission Inventory Methods

Rule 461 currently has annual throughput reporting requirements. It is designed to regulate gasoline vapor emissions from gasoline transfer and dispensing processes which contain volatile organic compounds and TACs such as benzene, ethyl benzene, toluene, xylenes, and naphthalene. The rule was initially adopted in 1976 and has been amended a number of times, most recently on March 7, 2008. Therefore, risk from these facilities can be calculated from the available information.

Emissions from gasoline transfer and dispensing mainly occur during loading, breathing, refueling, spillage, and hose permeation as described below:

> Loading – Emissions occur when a fuel tanker truck unloads gasoline to the storage tanks. The storage tank vapors, displaced during loading, are emitted through its vent pipe. A pressure/vacuum valve installed on the tank vent pipe significantly reduces these emissions.

> Breathing – Emissions occur through the storage tank vent pipe as a result of temperature and pressure changes in the tank vapor space.

> Refueling – Emissions occur during motor vehicle refueling when gasoline vapors escape through the vehicle/nozzle interface.

> Spillage – Emissions occur from evaporating gasoline that spills during vehicle refueling.

> Hose Permeation – Emissions occur when liquid gasoline or gasoline vapors diffuse through the dispensing hose outer surface to the atmosphere.

All retail service stations under SCAQMD jurisdiction have Phase I and II vapor recovery systems to control gasoline emissions. Phase I vapor recovery refers to the collection of gasoline vapors displaced from storage tanks when cargo tank trucks make gasoline deliveries. Phase II vapor recovery systems control the vapors displaced from the vehicle fuel tanks during refueling. In addition, all gasoline is stored underground with valves installed on the tank vent pipes to further control gasoline emissions. Out of the TACs emitted from the gasoline stations, only benzene, ethyl benzene, and naphthalene have cancer toxicity values.

The emission factors for each of the five processes are summarized in Table X-1. The factors given in the table follow CARB's recommended emission factors except that 95 percent control is assumed for Phase II vapor recovery or ORVR, whereas CARB assumes that the 95 percent control

for Phase II vapor recovery and ORVR are compounded. It is important to note that for purposes of modeling, Phase II emissions are broken up into refueling and breathing for dispersion modeling purposes.

Table X-1. Gasoline Emission Factors for Retail Service Stations

Process		Loading	Breathing	Refueling	Hose Permeation	Spillage
Controlled Gasoline EF (lbs/1,000 gal)		0.15	0.024	0.396	0.009	0.24
Benzene	**Weight Percent**	0.455%	0.455%	0.455%	0.455%	0.707%
	Emission Factor (lbs/1,000 gal)	0.000683	0.000109	0.0018	0.000041	0.0017
Ethyl benzene	**Weight Percent**	0.107%	0.107%	0.107%	0.107%	1.29%
	Emission Factor (lbs/1,000 gal)	0.000161	0.0000283	0.000467	0.0000106	0.0031
Naphthalene	**Weight Percent**	0.0004%	0.0004%	0.0004%	0.0004%	0.174%
	Emission Factor (lbs/1,000 gal)	0.0000006	0.000000096	0.00000158	0.000000036	0.000418

Note: Gasoline speciation profile: https://www.arb.ca.gov/ei/speciate/refspec.htm
The weight percentages of the TACs evaluated for cancer risk are listed here.

Modeling Parameters

For the general dispersion modeling methodology and meteorological stations used in the development of the screening tables, please see Appendix VI.

Emissions from gasoline service stations are non-buoyant and ground-based (or nearly ground-based). In addition, the peak impacts from this type of facility occur in close proximity to the source. Under these circumstances the local terrain is relatively unimportant; therefore flat terrain is assumed in the dispersion modeling.

CAPCOA has developed industry-wide risk assessment guidelines for gasoline service stations[6] (1997 CAPCOA Guidelines) and has started the process to update these guidelines using the 2015 OEHHA Guidelines and SCAQMD staff is participating in that Working Group. The current industry-wide risk assessment guidance was approved in 1997. These risk assessment guidelines were developed to promote consistency throughout the State. However, CAPCOA recognized that many of the districts in the State have developed modeling methods and procedures unique to their situations. To address these differences among districts, CAPCOA allows for a district to deviate from the published guidelines as evidenced by the following statement in the industry-wide risk assessment guidelines for gas stations[6]:

---

[6] The 1997 CAPCOA AB2588 Gasoline Service Station Industrywide Risk Assessment Guidelines are available on the internet at: https://www.arb.ca.gov/ab2588/rrap-iwra/GasIWRA.pdf

This effort was initiated to provide a cost effective and uniform method for calculating gasoline station emission inventories and risk assessment for the thousands of gasoline stations throughout the State. However, districts may use other emission information and modeling procedures appropriate in their district.

The modeling performed here follows the 1997 CAPCOA Guidelines unless otherwise noted.

Loading and breathing emissions exit the underground storage tank vent pipe and are thus treated as a point source. The height and diameter of the vent are assumed to be 3.66 meters (12 feet) and 0.05 meters (2 inches), respectively.

Refueling,spillage, and hose permeation emissions are modeled as volume sources with horizontal dimensions of 13 meters by 13 meters to correspond to the dimensions of the pump islands and a vertical dimension of 5 meters to correspond to the height of the canopy. For refueling and hose permeation, the release height is assumed to be 1 meter to approximate the height of a vehicle fuel tank inlet, whereas spillage emissions are assumed to be released at ground level since nearly all the gasoline from spillage reaches the ground. These dimensions match the 1997 CAPCOA Guidelines recommendations except for the vertical dimension of the volume source; CAPCOA recommends 4 meters. The SCAQMD has been requiring gas station risk assessments for permitting since early 1990s using a vertical dimension of the volume source corresponding to the pump island canopy top. Assuming a 5-meter vertical dimension continues this modeling practice.

According to the 1997 CAPCOA Guidelines, the effects of building downwash on the calculated cancer risk were determined by using three different scenarios with a 10 meter long by 5 meter wide, by 4 meter high building. The building downwash algorithms only affect point sources and do not affect volume or area sources. Results of the modeling indicated that the placement of the buildings and their subsequent potential to create downwash have very little effect on the resultant risks from the vent pipes. Thus, CAPCOA concluded that it is not necessary to include building downwash when determining the dispersion from the vent pipes when using ISCST3. In order to determine the effects of building downwash using AERMOD, a similar analysis was conducted by SCAQMD staff with the same building dimensions using the BPIP-PRIME computer program. The modeling results showed that building downwash caused the maximum ground level concentrations to more than double. Therefore, building downwash has a significant effect on the maximum concentrations and subsequent cancer risk and cannot be ignored.

The vent pipe, volume sources, and building are assumed to be located at the center of the service station property. Ideally, the locations of the vent pipes, pump islands, and buildings would be determined on a site by site basis. Unfortunately, that level of detail is not feasible for the development of screening tables due to the large number of facilities.

It is assumed that the gas station described above operates continuously throughout the year. Further, it is assumed that 80 percent of the daily emissions occur equally each hour from 6 a.m. to 8 p.m. and the remaining 20 percent of the daily emissions occur equally each hour from 8 p.m. to 6 a.m.

A sample AERMOD model input file for the generic retail service station described above is included in Appendix XIII, Exhibit X-1.

The peak model-predicted impacts at each downwind distance over the 36 azimuth angles are used to develop the screening cancer risk tables for gasoline service stations (see Attachment N, Tables 12.1A – 12.2B).

<u>Cancer Risk Screening Tables</u>
Based on a review of the 16 TACs emitted from gasoline, only three (benzene, ethyl benzene, and naphthalene) result in cancer effects and were analyzed for cancer risk. Cancer risk screening tables were developed for a generic retail gasoline service station. The modeled stations are assumed to have Phase I and II vapor recovery with cancer risk calculated for different locations; see Table X-1 for the control efficiencies and emission factors assumed for the modeling.

Cancer risks from a typical gasoline service station can be estimated from the screening tables as follows: First, determine which of the 24 meteorological site locations in these tables best represents the facility's meteorological conditions and location. The SCAQMD is broken up into 38 source/receptor areas (SRAs) as shown in Appendix VI, Figure VI-1. As shown in Appendix VI, Table VI-1, one of the 24 meteorological sites is assigned to each SRA, which can then be used to choose a meteorological site for each gasoline dispensing facility.

Next, determine the distance from the service station to the nearest residential and occupational location. Tables 12.1A – 12.2B in Attachment N provide the maximum cancer risks for a gasoline dispensing station with either underground or aboveground tanks with a one million gallon per year throughput at various residential and occupational distances, respectively. Using the above information, pick the cancer risk from the appropriate tables.

Lastly, scale the cancer risk by the actual gasoline throughput of the service station. An example of a risk calculation is provided for a hypothetical gasoline service station in a subsequent section.

<u>Results</u>
Figure X-1 shows the species apportionment and Figure X-2 shows the source apportionment of the calculated cancer risks. Using the results from the Ontario Airport meteorological station and at a distance of 25 meters, emissions from spillage account for 45% of the cancer risk, while benzene is the air toxics which drives the cancer risk, accounting for 85%. This is consistent with the discussion of the relative toxicity of substances in gasoline found in Appendix I of the 1997 CAPCOA Guidelines, which shows that benzene is the most important TAC driving the risk in the gasoline service stations.
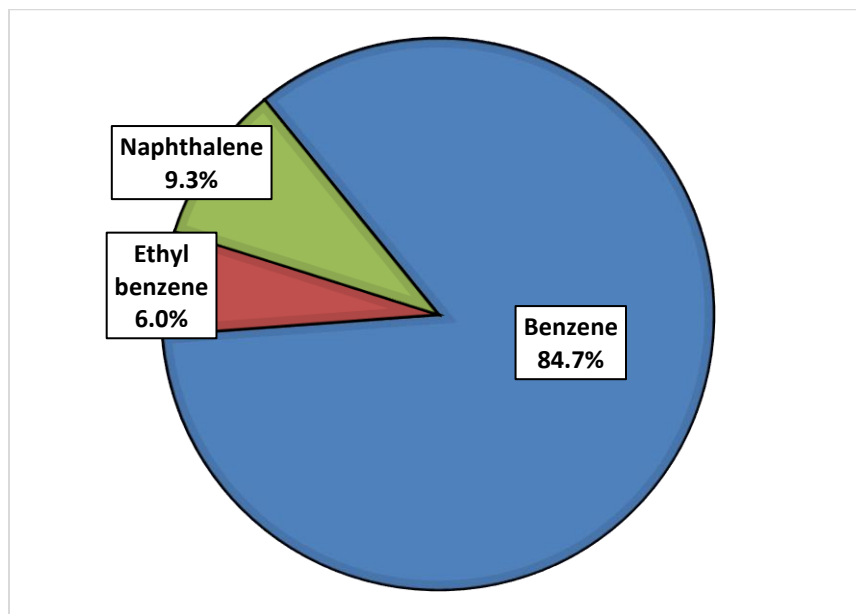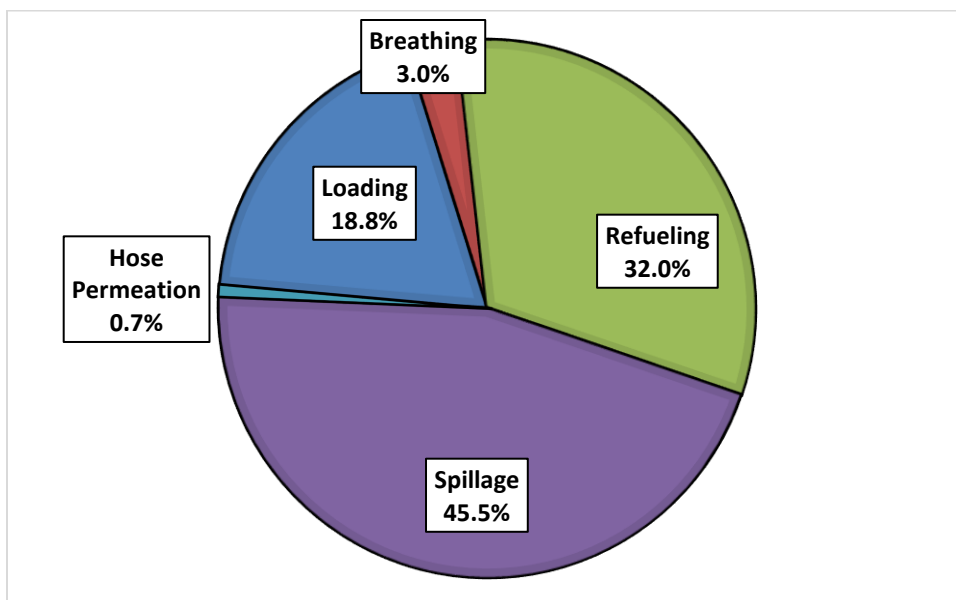
Figure X-1: Cancer Risk by Toxic Compound

Figure X-2: Cancer Risk by Source

Sensitivity Analysis Regarding Non-Cancer Risks

A sensitivity analysis examining the chronic and acute non-cancer risks was prepared using CARB's speciation profile of 16 TACs in gasoline, the Ontario International Airport meteorological station, a receptor distance of 25 meters, and a throughput of one million gallons per year. The TACs included in CARB's speciation profile are n-butyl alcohol, benzene, isoprene, naphthalene, 2-methyl naphthalene, o-xylene, 1,2,4-trimethylbenzene, cumene, ethyl benzene, p-xylene, m-xylene, toluene, hexane, cyclohexane, propylene, and 2,2,4-trimethylpentane. As seen in Table X-2, the senisitivty analysis calculated the Hazard Index (HI) for each of the 16 TACs, which was then summed, regardless of target organ.

Table X-2: Sensitivity Analysis Results for Non-Cancer Risks

TACs	Chronic HI	Acute HI
Benzene	0.02146	0.03186
Ethyl Benzene	0.00003	0
Naphthalene	0.00065	0
Toluene	0.00096	0.00011
m-Xylene	0.00019	0.00008
o-Xylene	0.00010	0.00004
p-Xylene	0.00008	0.00003
Hexane	0.00003	0
Propylene	0.00000004471	0
1,2,4-trimethylbenzene	0	0
2,2,4-trimethylpentane	0	0
2-methyl naphthalene	0	0
Cumene	0	0
Cyclohexane	0	0
Isoprene	0	0
n-Butyl Alcohol	0	0
Max Chronic HI	**0.02146**	**0.03186**
Million Gallons of Throughput to reach HI = 1.0	**46.59**	**31.39**

The results of the sensitivity analysis show that benzene is the driver for both the chronic and acute hazard indices, with risks from benzene being two orders of magnitude higher than the next highest TAC. Using CARB's speciation profile, seven of the 16 TACs did not have RELs associated with them. The maximum chronic HI was 0.02 and the maximum acute HI was 0.03 at a throughput of one million gallons of gasoline per year. The results demonstrate that for the maximum permitted risk of 10 in a million, the acute and chronic HI are much lower (< 0.1) than the threshold of 1.0. Therefore, the chronic and acute non-cancer health effects need not be calculated, which is consistent with the 1997 CAPCOA Guidelines.

Example Calculation

The following example demonstrates how the SCAQMD staff plans to estimate cancer risk values for retail gasoline dispensing facilities based on information received and using Attachment N, Tables 12.1A – 12.2B.

The calculation steps are as follows:

1. **Cancer Risk (CR):** Cancer risk values are estimated for each retail gasoline dispensing facility based on facility location, process information, and receptor proximity.

   a. *Residential CR:* Use the facility location and the distance to the nearest resident to identify the risk. The residential CRs for retail gasoline dispensing are contained in Attachment N, Tables 12.1A and 12.2A.

   b. *Off-Site Worker CR:* Use the facility location and the distance to the nearest worker to identify the risk. The occupational CRs for retail gasoline dispensing are contained in Table 12.1B and 12.2B.

   c. *Maximum Individual CR (MICR):* Select the greater CR between the residential and occupational CRs (as identified above).

Please note the following when calculating risk values for gasoline dispensing facilities:

   ▪ The gasoline dispensing risk tables (Attachment N, Tables 12.1A – 12.2B) are based on a gasoline throughput of 1 million (MM) gallons per year (gal/yr). Actual facility throughput should be multiplied by the values contained in the gasoline dispensing risk tables to calculate the appropriate facility risk.

   ▪ The SCAQMD maintains 24 meteorological stations that are processed for modeling purposes, as shown in Appendix VI, Figure VI-1 and Appendix VI, Table VI-I. The meteorological station that best represents the facility's meteorological conditions (such as prevailing winds), terrain, and surrounding land use should be used. This means that the closest meteorological station to the facility is not always the most representative meteorologically.

   ▪ The gasoline dispensing risk tables (Attachment N, Tables 12.1A – 12.2B) are based on discrete downwind distances. If the actual downwind distance is not listed in the tables, then linear interpolation between distance cells is acceptable.

   ▪ Although gasoline vapors and its TAC constituents (for example, benzene, toluene, and xylene) have non-cancer impacts, **the risks from retail gasoline dispensing facilities are dominated by cancer risk**. Therefore, hazard index for these facilities will not be calculated for inclusion in the gasoline dispensing risk tables.

<u>**Example:**</u> **A retail gasoline dispensing facility with an underground storage tank submits the following information: 15 MM gal/yr gasoline throughput, located in Yorba Linda, nearest residential receptor 200 meters away, and nearest off-site worker receptor 25 meters away.**

In this example the actual downwind distances are in the tables. However, if the actual downwind distances are not in the table, then linear interpolation between distance cells is acceptable to obtain cancer risks for the actual downwind distances.

1. **Cancer Risk (CR):**

    a. *<u>Residential CR:</u>* According to Appendix VI, Table VI-I, Yorba Linda is located in SRA 16 and the appropriate meteorological station is in Fullerton (KFUL). Using Attachment N, Table 12.1A for the Fullerton meteorological station, the residential cancer risk is 0.112 in one million (200 meters) for 1 MM gal/yr. Since the facility's gasoline throughput for this example is 15 MM gal/yr, the corresponding residential cancer risk is 1.68 in one million.

    Residential CR = $\dfrac{0.112 \text{ in one million}}{(1 \text{ MM gal/yr})}$ x 15 MM gal/yr

    > **Residential CR** = 1.68 in one million

    b. *<u>Worker CR:</u>* According to Appendix VI, Table VI-I, Yorba Linda is located in SRA 16 and the appropriate meteorological station is in Fullerton (KFUL). Using Attachment N, Table 12.1B, the occupational cancer risk is 0.239 in one million (25 meters) for 1 MM gal/yr. Since the facility's gasoline throughput for this example is 15 MM gal/yr, the corresponding occupational cancer risk is 3.59 in one million.

    Occupational CR = $\dfrac{0.239 \text{ in one million}}{(1 \text{ MM gal/yr})}$ x 15 MM gal/yr

    > **Occupational CR** = 3.59 in one million

    c. *<u>MICR:</u>* The MICR for this retail gasoline facility is **<u>3.59</u>** in one million (occupational receptor).